Poster III-70

Virtual Environments for Surgical Simulations Over Best-Effort Networks
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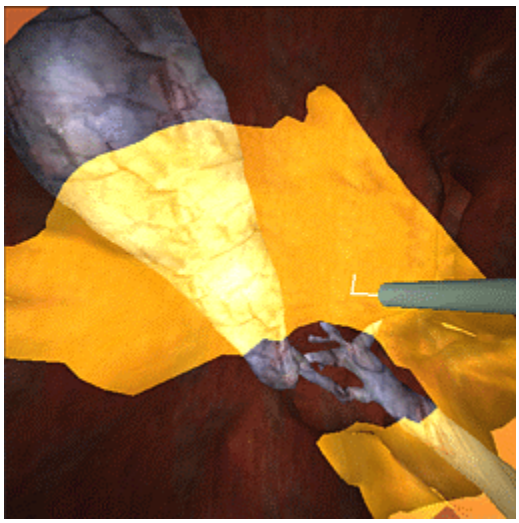
Virtual environments are a promising new direction for surgical training, planning, and research. The user interacts with the virtual environment through haptic devices that allow him to manipulate simulated surgical equipment (e.g., scalpels and laparoscopes) on a simulated organ (i.e., no mannequin is involved). Simulations are interactive; can be recorded, replayed, and evaluated; can support training and research with different techniques and uncommon but critical scenarios; and are especially suitable for training in minimally invasive surgery, which makes use of an abstract and restricted user interface. Accessibility to virtual environments would be greatly enhanced by networked simulations, whereby a simulated physical process is remotely accessed through regular Internet-connected computers and the corresponding user interfaces. Our long-term vision is that a compelling surgical environment should be continuously accessible anytime at any appropriate location, including a trainee's own computer. Networked simulation can support remote education and team training, access to high-performance computational facilities, and the integration of a portfolio of expensive simulation modules. However, current networks operate in the best-effort model, where no guarantees are given regarding available bandwidth, packet losses, delays, and jitter. In turn, the lack of Quality-of-Service provisioning degrades the realism and effectiveness of networked simulations.

Our objective is to support surgical simulations over the Internet by creating a software infrastructure that enables the communication end-points to adapt to time-varying rates of information exchange. The research would align surgical networked simulations with the fundamental technical, economic, and pragmatic realities of today's best-effort Internet. In the poster, we will describe our previous, current, and planned research. Our previous work includes a virtual environment for laparoscopic surgical skills (see figure), an open-source modular and flexible framework for surgical simulations called GiPSi, and sampling and control strategies for the network control of physical environments or physically realistic simulations. We will then outline our plans to extend GiPSi to a network setting, our planned investigation in the area of techniques to reduce bandwidth requirements, speculate on a broad range of end-point middleware methods to compensate for network vagaries, and outline the rationale and planned validation of our approach.



Laparoscopic Cholecystectomy Simulator.